Hazards in the workplace

World at work: Fish processing workers

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Spotlight on a growth industry

The fishing and fish processing industry has experienced tremendous growth in recent years. In 1990 the Food and Agriculture Organisation (FAO) estimated that the number of people engaged in fishing, aquaculture, and related activities worldwide doubled to 28.5 million from 1970.[1] Among these workers 52% worked aboard fishing trawlers, 32% were involved in aquaculture production (marine and freshwater), and 16% worked inland as capture fishers or in other land based activities such as processing. Ninety five per cent of these workers were from developing countries, producing 58% of the 98 million tons of world fish. Increased levels of production and processing of seafood have led and continue to lead to more frequent reporting of occupational health problems such as asthma among fish processing workers.[2] These occupational health problems result in increased incapacity and absenteeism among affected workers, with women more affected as a result of differences in physical exposures and psychosocial work environments.[3 4]

THE FISHING INDUSTRY IN SOUTH AFRICA

The fishing industry in South Africa employs approximately 30 000 workers in direct employment in more than 100 workplaces and 60 000 workers in related jobs, supplying food for the entire Southern African sub-region. Labour in this industry tends to be divided along gender lines, with men almost exclusively going out to sea to catch the fish and women doing the majority of on-land processing. A large proportion (62%) of the workforce in fish processing plants is female and at least one third of the workforce is employed on a seasonal basis by the industry. In 1999, the total harvest of seafood amounted to 571 924 tons, among which bony fish such as anchovy, hake, and pilchard are the most common seafood processed. This was confirmed in a recent postal survey in which 76% of all seafood processing workplaces processed bony fish.[5]

FISH PROCESSING WORK ENVIRONMENT

Work processes, job tasks, and working practices

Fish processing plants in South Africa, as in other parts of the world, vary in technology levels, with smaller workplaces relying entirely on manual handling of fish and larger companies using modern highly automated processes. Various processing techniques are used and include heading, degutting, skinning, mincing, filleting, trimming, cooking (boiling or steaming), spice/batter application, frying, fishmeal milling, and bagging. A study of South African workplaces indicated that freezing (71%), cutting (63%), and degutting (58%) ranked the most common.[5] Among the finfish, hake (filleted, fried, spice/batter applied), pilchard (canned), and anchovy (minced into paste and fishmeal production) were commonly processed (table 1).

Workplace hazards and high risk work

The health problems among fish processing workers have been attributed mainly to safety risks (mechanical and electrical accidents); excessive noise levels and low temperatures; bacterial and parasitic infections; bioaerosols containing seafood allergens, microorganisms, and toxins; and poor ergonomic practices and workplace organisation. These commonly result in fatal or non-fatal injuries and occupational diseases such as frostbite and aggravation of Raynaud's phenomenon;[6] noise induced hearing loss;[3] skin infection and sepsis;[7] allergic respiratory diseases (rhinoconjunctivitis, asthma, extrinsic allergic alveolitis) and skin conditions (urticaria, contact dermatitis);[2 8] musculoskeletal cumulative trauma disorders;[9 10] and stress related health problems[3] (table 2). The reported prevalence of occupational asthma associated with fish processing is 2–8%, and occupational protein contact dermatitis (PCD) and urticaria is 3–11%.[2] Musculoskeletal disorders of the neck and shoulders occur in 31–35% of the workforce, with younger untrained or unskilled women being more adversely affected. The prevalence of epicondylitis and carpel tunnel syndrome is much lower (15%).[9 10]

The adverse non-immune (toxic) and immune (allergic) reactions to seafood are the result of exposure to the seafood itself (muscle and connective tissue, exoskeleton, blood, endolymph fish juice, skin, skin slime/mucin, entrails) or to various non-seafood components present in the product (table 2).[2]

Aerosolisation of the seafood during processing has been identified as a potential high risk activity for immunological sensitisation by high molecular weight proteins, respiratory symptoms, non-specific bronchial hyperresponsiveness, and work related asthma.[2 11 12] Processes include degutting, heading, and cooking/boiling of fish, mincing of seafood, fishmeal milling/bagging, and cleaning of the processing line and storage tanks with high pressured water (table 1).[2] Despite high levels of automation in larger workplaces, workers may still be at high risk of developing health problems due to inadequate and poorly designed local exhaust ventilation systems (figs 1–2).[11] There is great variability of exposure to bioaerosols with allergen concentrations ranging from 2 ng/m^3 in a fish market to 1000 ng/m^3 in a salmon processing plant.[2 11 12] Wet processing activities (grading, gutting, packing fish, automated gutting machine) in salmon filleting plants appear to produce higher particulate (respirable fraction) concentrations than dry activities (fish butchery, packing in cold store and box store).[11] Consistently high mean fish antigen concentrations (thoracic fraction) have been detected in fishmeal loading and bagging activities ($>$100 ng/m^3) compared to fish canning activities in South African workplaces processing anchovy and pilchard fish respectively. Fishmeal operations also produced consistently increased levels of endotoxin ($>$50 endotoxin units (EU)/m^3 or $\sim$5 ng/m^3). While no threshold limit values currently exist for exposure to fish or other seafood allergens, a level of 50 EU/m^3 has been proposed for endotoxin related health effects.[13]

Occupational dermal exposure occurs mainly as a result of unprotected handling of various fish and their products at various stages in the production process (table 2; fig 3). Fish juice contains high molecular weight proteins, biogenic amines, histamine and cadaverine, degradation compounds in old fish, and digestive enzymes (pepsin and trypsin).[2 8] The major skin manifestations associated with exposure are contact urticaria and eczematous contact dermatitis of various types. Contact with

Table 1 Commonly observed production activities and sources of occupational exposure to seafood products in the fish processing industry of the Western Cape province of South Africa

Production activity	Main fish type	Description of processing steps	Sources of occupational exposure to seafood product(s)
Fish canning	Pilchard (*Sardinops ocellata*)	• Fish pumped from holding tanks to sorting tables • Fish hooked and aligned manually on conveyor belt • Moves through autopacker for decapitation and degutting before inserted into cans • Steamed in exhaust box oven • Drainer removes excess water by tipping cans • Tomato based sauce and spices added • Cans sealed, autoclaved, labelled, and packaged	• Inhalation of wet aerosols during degutting and cooking/boiling • Skin contact from unprotected handling of various fish and fish juice
Fish filleting	Hake (*Merluccius capensis, M paradoxus*)	• Small plants: mainly manual cutting and degutting • Large plants: fully automated machines performing degutting, heading, skinning, filleting, grading, and trimming to specific sizes • Cryogenic technology used to freeze fish fillet • Phosphates added when frozen and stored	• Inhalation of wet aerosols during degutting and heading • Skin contact from unprotected handling of various fish and fish juice
Fishmeal production	Anchovy (*Engraulis capensis*) Pilchard offal	• Fish stored in pits, formalin added to stabilise fish • Fish transferred from pits by hoppers • Cookers boil the fish in an enclosed process • Mixture transported to pressers and de-sludger which separates liquid from solid fraction • Conveyed to dryers at high temperatures • Passes through hammer mills forming finer particles • Fine powder blown onto hopper using industrial fans • Hoppers transfer product to bagging section where fishmeal poured into Hessian bags (semi-automated) • Spilled fishmeal manually swept, shovelled, and tipped into bags	• Inhalation of formalin, hydrogen sulphide gas from decomposing fish in pits • Inhalation of dry dust aerosols during fishmeal bagging

the proteinacious fish material causes a chronic recurrent dermatitis commonly known as protein contact dermatitis (PCD). At least 75% of eczematous dermatitis cases are however of an irritant nature due to contact with water and products in fish juice.[8] Other chemical agents (hand cleaners, soaps, detergents) used by workers also cause an irritant contact dermatitis. Biochemical sensitisers (for example, garlic, onion, spices, mustard) added to seafood produce a delayed allergic contact dermatitis.

Measures to protect workers

Primary preventive measures are key to minimising exposure to workplace hazards that result in occupational injuries or diseases. These include surveillance of exposures, injuries, and diseases; analysis of surveillance data to

Table 2 Commonly observed hazards, causative agents, and associated health effects in the fish processing industry

Hazard category	Causative agents/processes	Health effect(s)
Safety	Unprotected machinery	Hand trauma (cuts, lacerations, calluses)
	Wet surfaces causing slips and falls	Sprains and fractures
	Electrical cables on wet surfaces	Electrocution
	Splashing of fish secretions (bile)	Corneal erosions
Physical	Noise (cannery)	Noise induced hearing loss
	Low temperatures (freezers) and wet environments	Hypothermia, frost-bite, Raynaud's, asthma aggravation
Chemical	Sensitisers (formalin, printing inks, glue)	Rhinoconjunctivitis, asthma, dermatitis
	Irritants (handcleaners, soaps, detergents)	Dermatitis, rhinoconjunctivitis, asthma
	Toxic gasses in fish holding tanks (hydrogen sulphide)	Asphyxiation
	Hypertonic saline aerosols (sea water)	Aggravation of asthma symptoms
Biological	Spiny fish	Hand trauma (puncture wounds, lacerations)
	Fish toxins	Toxic reactions (local/generalised)
	Fish proteins (muscle, blood, enzymes)	Rhinoconjunctivitis, asthma, urticaria, dermatitis
	Vegetable dust additives (garlic, spices)	Rhinoconjunctivitis, asthma, urticaria, dermatitis
	Parasites (*Anisakis*)	Infection, rhinoconjunctivitis, asthma, urticaria
	Microorganisms (*Vibrio*, hepatitis A)	Wound infection, sepsis
	Bacterial toxins (endotoxin, histamine)	Organic dust toxic syndrome, mucous membrane irritation, rhinoconjunctivitis, asthma, urticaria
	Mould in wet, damp, humid environments	Infection, rhinoconjunctivitis, asthma, urticaria, hypersensitivity pneumonitis
Ergonomic	Repetitive work (cutting and trimming of fillets), forceful motions of upper limbs, constrained neck postures (sorting), prolonged standing (grading, sorting), loading bags and cans	Musculoskeletal cumulative trauma disorders (neck pain, shoulder girdle pain, elbow pain/epicondylitis, wrist pain/carpal tunnel syndrome, lower backache)
Psychosocial	Excessive speed on workline, poor workplace organisation	Stress related symptoms (anxiety, insomnia, digestive problems), fatigue

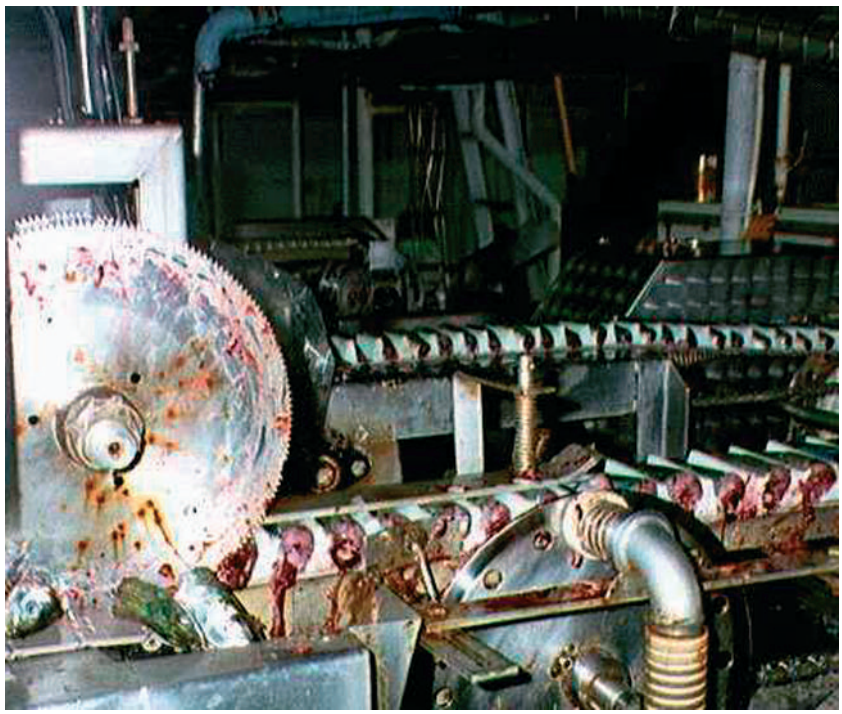

Figure 1 Degutting and heading of pilchard generating bioaerosols and safety hazards in the cannery. Enclosure of the autopacker machine will substantially reduce health risks.

assess risk and identify trends; control of workplace hazards through engineering controls, personal protective equipment, and administrative procedures; and education and training programmes for workers to ensure adequate precautions.[14]

The control of exposure to physical hazards such as excessive noise and cold temperature is standard to any type of industry. Primary preventive measures for excessive noise exposure among cannery and fishmeal operators require the institution of hearing conservation programmes. These encompass engineering controls such as enclosure of the source to reduce levels below 85dBA; demarcation of noise zones and sign posting; wearing of hearing protective devices; monitoring noise levels; and regular audiometry to detect early warning signs of noise induced hearing loss (fig 2).[15] Reducing health risks associated with cold temperatures exacerbated by wet conditions include: limiting duration of exposure in refrigeration sections; wearing of adequate insulating clothing and personal protective equipment (gloves, boots); adequate rest periods in dry and warm air-conditioned restrooms; and sufficient nutrition and warm beverages.[6]

Figure 2 Bagging of fishmeal causes spillage and aerosolised dust particulate if inadequately removed by local exhaust ventilation systems. Hearing protectors are worn by some workers. Mechanical hoisting of bags prevents ergonomic hazards.

South African regulatory standards for bioaerosols are based on the well known European directive no. 2000/54/EC dealing with the protection of workers from risks related to exposure to biological agents at work.[14 16] The health risks associated with exposure to biological agents (microbial agents, allergens, and toxins) depend on the degree of pathogenicity or toxicity of the agent, the route of transmission, and the level of exposure to the agent. Control measures to reduce the emission of bioaerosols in fish processing plants include process separation or enclosure and the use of local extraction ventilation systems to processes and equipment (gutting machine, fishmeal bagging) (figs 1 and 2). Fitting a local exhaust ventilation system in a salmon processing plant reduced the overall mean respirable aerosol concentration from 2.37 mg/m^3 to less than 0.01 mg/m^3.[11] This resulted in no new cases of occupational asthma over a 24 month period versus an initial 8% prevalence prior to the intervention. Where there is skin contact with the hazardous agent (fish sorting, spice mixing), appropriate gloves (cotton lined) and plastic sleeves can be worn (fig 3). Puncture wounds and lacerations should be treated expeditiously to prevent infection and skin exposure to allergens in fish juice. An appropriate combination of emollients and moisturisers can be used prophylactically to protect skin barrier function and prevent the development of irritant contact dermatitis.[8] Special care should be taken when instituting preventive measures that one hazard is not replaced by another, such as using latex gloves and inadvertently causing latex allergy.

Exposure monitoring for bioaerosols (for example, bacterial/spore counts, endotoxin or allergen levels) can evaluate the effectiveness of control measures in decreasing the risk of infection and/or allergic sensitisation of other, as yet unaffected, workers. Medical surveillance programmes can be used as a useful adjunct to industrial hygiene evaluation and control measures. Various early subclinical biomarkers (for example, serum eosinophilic cationic protein, skin prick testing with fish extracts, fish specific serum IgE or IgG antibodies) and target organ tests (for

Figure 3 Fish sorting activities generate ergonomic hazards due to high conveyor belt speed, repetitive work, prolonged standing, and abnormal postures. Unprotected handling of fish results in irritant contact dermatitis and urticaria.

example, non-specific bronchial hyperresponsiveness, skin patch tests with fresh fish) can be used to detect early inflammation, allergic sensitisation, or adverse health outcomes such as asthma, extrinsic allergic alveolitis, or contact dermatitis among affected workers.[2 14]

Improvements in workplace design, such as introduction of conveyor belts for transporting fish at reasonable speeds; adjustable tables and platforms to stand on; adjustable sit/stand stools; provision of foot rests; and anti-fatigue mats have an important role in dealing with ergonomic hazards (fig 3).[17–19] In situations where personal protective equipment is indicated, proper fitting gloves should be provided so as to reduce the hand and finger force required to perform a repetitive task. Aside from ensuring appropriate design of hand tools, workers should be educated in maintaining a neutral wrist when performing repetitive motions in the fish filleting and sorting departments. In the bagging and packing departments, the use of mechanical lifts for loading cans and fishmeal bags and training on correct lifting techniques will alleviate back stress and prevent injury (fig 2). Improved workplace organisation, including the formation of joint health and safety committees, participatory management styles, well defined organisational philosophies on occupational health and safety, modified work provision post-injury at work, job rotation, and recognition of other local pyschosocial stress factors (for example, gender roles, seasonal work, low income) will have an impact in reducing work related stress and cumulative trauma disorders among fish processing workers.[3 20]

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